

of self-supply, the fraction of output that can currently be supplied by a third-party competitor greatly overestimates the incumbent LEC's ability to raise price profitably.

To help size the structural question, let us calculate the market shares associated with the CMA 25 percent criterion. Suppose there were a single alternative supplier, for example, a CAP, and suppose that the LEC and the CAP were equally efficient and equally capable of selling service to any customer whom they could reach.<sup>44</sup> In this case, the USTA's 25 percent rule would result in the CAP serving about 12.5 percent of the market and the LEC serving the remaining 87.5 percent, assuming each were equally likely to serve customers that they both could reach. Even if the LEC were able to maintain a market share of 87.5 percent in this hypothetical CMA, there are several reasons why the USTA-proposed pricing flexibility would not necessarily lead to the exercise of market power and higher prices.

First, this market share measure includes only usage sold by the LEC and by third parties such as CAPs and, soon, cable companies. It does not--and cannot--measure the competitive response of interexchange carriers to price increases in circumstances where they have the same ability to interconnect with the LEC network as the CAPs and the cable companies. When an IXC plans its network expansion, it takes into account access savings that it can achieve by constructing facilities in certain locations and by leasing facilities from CAPs or LECs in other locations. The net effect of such cost-reducing behavior on the part of all interexchange carriers is to force the LECs to reduce carrier access charges or suffer the loss of components of carrier access demand. Hence as an input into the calculation of market power, measured market share in the carrier access market is biased downward.

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<sup>44</sup>The assumption that the LEC and CAP would divide equally the customers they both could reach in a CMA may be conservative because the LEC is more heavily regulated than the CAP with respect to such important strategic parameters as contract review and tariffing delays.

Second, a workable method of implementing the proposal would be to calculate the fraction of observed carrier access demand that lies within a certain distance (e.g., 3,000 feet) of a CAP's backbone or feeder network. If that fraction exceeds 25 percent (and if a sufficient fraction of customers are actively seeking competitive alternatives to LEC services), the CMA would be classified as competitive. This method of measuring the proportion of demand having competitive alternatives would be conservative, because (i) it relies on necessarily incomplete knowledge of the CAPs' current and planned networks, and (ii) it ignores interexchange carrier networks.

Third, the measure ignores the presence of pockets within the wire center--such as business parks or large office complexes--for which competitive alternatives exist regardless of the distance to an existing CAP facility. Effectively, the proposed method simplifies the relationship between customer traffic volume and distance from the CAP's backbone network for which a direct connection would be cost effective, unless the IXC begins to use that network and provides directly connected end-user services.

Fourth, the measure ignores the presence of expanded interconnection which permits CAPs and interexchange carriers to use LEC facilities to aggregate traffic which is far from their networks. It also measures the potential success of competitors by the fraction of demand their networks currently reach rather than focussing on the fraction of demand that the CAP and IXC networks can reach economically using expanded interconnection where it is available.

Fifth, the 25 percent standard is conservative because it ignores traffic aggregation in determining whether a customer can obtain an alternative source of supply. If a LEC maintained access prices above their competitive level for small customers, aggregators and resellers would be able to profit by gathering traffic from small customers and sending it directly to the CAP or to the interexchange carrier. The relatively low cost of aggregating different customers' traffic in an environment where the LEC permits resale of its services places a strict limit on the LEC's ability

to charge high average access prices for serving small customers. Thus, with a relatively minor incremental investment, the competitor would be able to reach a higher percentage of the carrier access customers than would be suggested by the proposed 25 percent criterion.

Finally, the standard underestimates the fraction of traffic that can be served economically by the CAP because it omits traffic that could be served if the existing CAP network were extended in the most profitable directions within the wire center. While some customers may, individually, be too far away from the CAP's current network to warrant direct connection or too small to warrant aggregation, the fact that several such customers might be located along a single cable route would mean that interexchange carriers would have competitive alternatives to the LEC in supplying carrier access to those locations. Such customers need not be sufficiently large for direct connection and need not deal with a traffic aggregator. They would still have competitive alternatives for carrier access services because it would pay a CAP (or an interexchange carrier) to extend its network along a route that would serve enough such customers to be economical.<sup>45</sup>

In summary, there is no magic formula that provides a structural indicator that could signal when market power was a threat and when it was not. What is required is a standard of substantiality of competition, giving rise to the reasonable expectation of a potential for competition and an absence of barriers to entry or to interconnection. It is not necessary to have a successful competitor to constrain the possible market power of a regulated local exchange carrier, and a policy that artificially encouraged entry until successful competitors reached an arbitrary but substantial size would be entirely self-defeating. It is not at all clear that CAPs, cable companies--or, indeed, LECs have a truly permanent economic role in linking long distance companies with their customers. As different technologies as well as different firms enter these markets--we have in mind in particular

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<sup>45</sup>Note that a relatively small route extension to a network already reaching 25 percent of the traffic in a wire center can provide competitive access alternatives to the bulk of the traffic.

radio-based access to the end user--regulation based on market shares of competitors could do unimaginable harm to telecommunications consumers. Billions in uneconomic investment could be encouraged, and pricing could then be distorted by regulation in order to protect that investment from competition.

## **2. Anticompetitive Pricing**

Customer-specific prices and quantities tariffed under the pricing flexibility permitted in a CMA would be removed from the calculation of the SBI and API for price cap companies--and from the calculation of the historical revenue requirement for traditionally-regulated companies.<sup>46</sup> Hence price reductions to meet competitive offers would not reduce the LEC's API for carrier access services, so no change in price limits in less-competitive wire centers would be made possible by the price reductions to meet competition. As observed in our analysis of TMAs, this feature of the proposal ensures that the additional pricing flexibility requested in the USTA proposal will not increase the LECs' ability or incentive to subsidize its access services in competitive wire centers.<sup>47</sup>

Neither the ability nor the incentive to engage in other forms of anticompetitive pricing would be increased by the pricing flexibility requested in the USTA proposal, and eliminating the ability to cross-subsidize reduces the ability to engage in predatory pricing or an anticompetitive price squeeze. Both of these strategies require sacrifice of current profits in order to disadvantage rivals, and there is nothing in the requested pricing flexibility that would increase the likelihood that such a strategy could be profitable. The ordinary antitrust standards for predatory pricing and for a

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<sup>46</sup>Indeed, all prices and quantities in CMAs would be removed from the price cap calculations.

<sup>47</sup>The USTA proposal to eliminate sharing has merit. Indeed, eliminating sharing would not increase the LECs' ability or incentive to subsidize any access service but would provide better protection against cross-subsidization. By eliminating the upper and lower earnings bounds--a legacy of rate-of-return regulation--the incentive to artificially drive earnings below the lower threshold so that prices could be increased in the following year would disappear. Mechanically, eliminating sharing would open markets to streamlined regulation without requiring arbitrary cost allocation procedures to assign costs and investment to services.

vertical price squeeze are readily applied to the carrier access market. If prices of all competitive carrier access services equalled or exceeded their long run incremental costs, the LEC would meet the predatory pricing standard promulgated in *MCI Communications Corp. v. AT&T Co.*<sup>48</sup> Similarly, if the prices of competitive carrier access services equalled or exceeded the sum of their long run incremental costs plus the contribution foregone by providing any essential facilities to CAPs instead of retail service, the LEC would meet the *ALCOA* test for a vertical price squeeze.<sup>49</sup> In both cases, there is no reason to believe that classification of a wire center as a CMA would increase the likelihood that these anticompetitive pricing tactics would be profitable.

Finally, pricing flexibility is increased under the proposed plan, so within a CMA is it not likely that undue price discrimination will result? LECs could reduce prices under contract-based tariffs to large customers having competitive alternatives, and nothing compels them to make such discounts available to customers having no such alternatives. As in the TMA analysis however, the degree of price discrimination (if any) stemming from such flexibility is precisely the degree sanctioned by the emerging competitive market. Unless CAPs are price-regulated and forced to provide service ubiquitously--and unless IXCs were required to purchase access services from LECs and CAPs rather than engage in self-supply--such prices will be market-determined. Whether or not it is in the public interest, competition will bring lower prices to large business customers rather than uniformly lower prices to all consumers. Such pricing is an inevitable consequence of competitive entry, and no good will come from attempting to forestall this consequence by restricting the LEC's ability to charge lower prices to competitively-advantaged customers. The main effect of such an

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<sup>48</sup>708 F.2d 1081 (7th Cir. 1982), *cert. denied*. 464 U.S. 891 (1983).

<sup>49</sup>*United States v. Aluminum Company of America*, 148 F.2d 416 (2d Cir. 1945). The extent to which LECs provide any essential facilities--beyond the right to interconnect--to CAPs is open to dispute.

attempt would be to lower efficiency by preventing LECs from competing where they are low-cost suppliers.

### **3. Efficiency gains from pricing flexibility**

Restricting LEC pricing flexibility to competitive wire centers may to some extent help control the exercise of LEC market power, but the additional protection is not free. Moreover, timing is essential, and a policy that permits pricing freedom to respond to competitive entry after entry has occurred has very different consequences from one in which potential entrants are shown proper pricing signals. Again, in the Commission's words:

"Although some parties suggest that we delay any increase in LEC special access pricing flexibility until competition has developed further, competition is already developing relatively rapidly in the urban markets and will only accelerate with the implementation of expanded interconnection. Thus, delay in providing LECs with any additional pricing flexibility appears unwarranted. This is particularly true with regard to the current study-area-wide rate averaging, which forces the LECs to price above cost in the urban areas where competition is most intense.

Retention of study-area-wide rate averaging could create a pricing umbrella for the CAPs and deprive customers of the benefits of more vigorous competition. It could also undermine efficiency by preventing the LECs from competing effectively even when they are the low cost service provider. Handicapping the LECs in this fashion could also increase their competitive losses under expanded interconnection, bringing upward pressure to bear on LEC rates for less competitive service, including those used by residential customers."<sup>50</sup>

### **D. Provisions for small LECs**

Two separate parts of the USTA proposal address the needs of small LECs. Pricing flexibility in a TMA is offered to non-price-cap-regulated LECs. As described above, they must either accept a band of pricing flexibility similar<sup>51</sup> to that for the price cap LECs or effectively

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<sup>50</sup>Special Access Order at ¶¶ 177-178.

<sup>51</sup>While the bands appear to be only half as wide as those for the price cap LECs, carriers only file every other year.

submit to a price-cap-like constraint on the ability of price changes to increase the revenue for an access category above its most recent revenue requirement. As a separate mechanism, USTA proposes that non-Tier 1 LECs be permitted to assign wire centers to TMA or CMA status if they are adjacent to a Tier 1 LEC wire center that meets the TMA or CMA criteria.

The first arrangement for small LECs makes economic sense, because it tries to impose the same type of constraint on the smaller LECs that price cap regulation would apply to the larger LECs. The contiguity arrangement requires a judgmental tradeoff between the cost of imposing filing requirements on small LECs and the cost of granting CMA pricing flexibility where competition is only in an adjacent wire center.

Of course, competitors do not need to serve the entire wire center in order to be able to serve individual large customers within a wire center. Picture a small-LEC wire center in a suburb, adjacent to a large-LEC urban wire center. A CAP network might choose to interconnect with the public switched network at the large-LEC wire center, because of customer density, facilities availability, or possibly lower prices. Wherever the CAP chooses to interconnect, a large office park or military base in the small-LEC wire center would be vulnerable to competition. Proximity of high-volume customers to the CAP network determines whether or not those customers have competitive alternatives, and the location of the wire center at which the CAP interconnects has little effect on those customers' choices.

## V. Conclusion

Carrier access prices were originally set using the fully allocated costing methods of the Part 69 rules. These prices initially bore no direct relation to economic costs, but with only limited competition for carrier access services, uneconomic pricing had only allocative efficiency and distributional consequences. Price cap regulation created additional pricing flexibility for these

services, and part of the rationale for price regulation was that it would permit a gradual, flexible transition from fully distributed cost-based prices to market prices within the limitations of the price cap plan. Technical change and expanded interconnection have increased the tempo of change in the carrier access market. With expanded interconnection, the market is, for all practical purposes from the standpoint of overall economic efficiency, opened for competition. Pricing flexibility for incumbent firms has thus become much more critical.

Competitors--CAPs, IXCs, cable companies, cellular and PCS providers--have different skills and interests, and they will seek out different niches of telecommunications markets to favor their particular advantages. Their plans may require different mixtures of purchasing interconnection services from incumbent LECs or each other, or providing interconnection transport, switching and possibly loops themselves. For technical economic efficiency, it is imperative that these decisions be made with a realistic view of the costs of the services that the incumbent, existing network can provide. Otherwise, costs will be sunk in uneconomic assets, and the lower prices promised by the Commission's open entry initiatives will be dissipated among telecommunications suppliers rather than distributed to customers.

In our view, the benefits from additional pricing flexibility for LEC carrier access services are important. The additional pricing flexibility requested for TMAs--beyond that currently granted through zone density prices and term and volume discounts--is small, and there is no reason to believe that such flexibility could have anticompetitive consequences. More flexibility is requested for CMAs, but the competitive standard is appropriately higher. Economics cannot tell if 25 percent is the right number compared with 20 or 30, but the structure of the proposal--grant flexibility when a substantial fraction of customer demand has a choice of suppliers--is exactly right. The proposal is conservative because measuring the fraction of customer demand sufficiently close to CAP facilities ignores the fact that (i) individual large customers can choose a CAP as their provider even

if customer density is generally low in a wire center, and (ii) use of the observed share of CAP supply provides an underestimate of the appropriate market share for measuring the ability of the LEC to raise its price because of self-supply on the part of IXC's and CAP's.

The USTA criteria will engender economic efficiency incentives that support the FCC's stated goals for carrier access regulation. Customers that would be able to purchase access services from the LECs, CAPs or other competitors at the most efficient and lowest price are the beneficiaries of the plan. Without the proposed pricing flexibility for all LECs, the benefits of competition will not accrue to customers, and carrier access competition may raise industry costs and prices rather than lowering them.

**ATTACHMENT 5**

**Economic Performance of the LEC Price Cap Plan**

**by**

**National Economic Research Associates, Inc.**

# **ECONOMIC PERFORMANCE OF THE LEC PRICE CAP PLAN**

Prepared for  
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## SUMMARY

The purpose of the Commission's inquiry is to assess the economic performance of the LEC price cap plan. This report focuses on how the major components of the price cap index formula, the measures of inflation and the productivity offset have worked. Based on our analysis of the available data, we conclude that these two components are working within the anticipated range of outcomes and that an increase in the productivity offset would significantly dilute the very incentives that plan was established to achieve.

In the following sections, we first examine the relationship between economic efficiency and the incentives facing the regulated firm under price cap regulation. The heart of the LEC price cap plan is the annual adjustment formula. We derive the price cap formula using basic economic principles and demonstrate its reliance upon appropriate measures of U.S. inflation, a productivity offset, and adjustments for exogenous cost changes. Regarding inflation, we find that although the numerical differences are negligible, there may be slight theoretical advantages to using the GDP-PI in place of the GNP-PI and significant practical advantages. We see no risk in terms of diluting incentives from making this particular change in the middle of the operation of the plan.

Productivity is most closely examined. We derive the theoretical relationship between the total factor productivity (TFP) growth of the regulated firm and the productivity offset (X) in the annual price adjustment formula. From our analysis we conclude that an appropriate productivity offset is the historical differential between the annual TFP growth of the regulated LEC industry and that of the U.S. economy.

Measured in this way, the productivity offset includes the effect of any growth in minutes of use per line ("g" in the balanced 50/50 formula adopted by the Commission in the common line basket) because the LEC's measured TFP growth uses actual growth of both minutes and lines as the measure of output. Also, measured directly, LEC TFP uses an estimate of capital input which more accurately reflects economic asset lives rather than the artificial accounting asset lives which are embodied in the LEC data used to estimate the productivity offset in the indirect method employed by the Commission in 1990. Most importantly, we also observe that the productivity offset should be stable over a long period of time, and the price cap review should not be used to true up the productivity offset because of successes or failures of the regulated firms under the plan.

The Notice of Proposed Rulemaking (NPRM) sought comment as to whether the Commission should adopt a mechanism which would adjust the plan to reflect changes in interest rates or whether a one-time change in the LEC's price cap index should be required.<sup>1</sup> We examine these questions and find that the plan as originally articulated properly adjusts prices to reflect changes in interest rates and that there is no basis for a one-time change of the price cap index. No special adjustment for changes in interest rates is required because changes in interest rates represent changes in the input prices that affect every industry in the U.S. While changes in capital, labor or raw materials prices may affect the costs of different industries differently, depending on the mix of inputs used, we show that differences in input price growth rates are implicitly part of the productivity offset in the plan. Thus interest rate changes--as well as changes in other

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<sup>1</sup>NPRM, CC Docket No. 94-1, Released February 16, 1994, Paragraph 46.

input prices--are accounted for through (i) the measure of U.S. inflation (GNP-PI) and through the productivity offset which accounts for any differences between U.S. and industry input prices. The price cap-regulated firm thus does not automatically benefit when input prices fall; rather, it benefits only to the extent that it can adapt its inputs to the change in prices so that its costs fall relative to costs of other firms in the economy.

In theory, the purpose of the price cap review is to ensure that there are no gross errors in the components of the formula as established in 1990. Our assessment of the economic performance of the components of the formula to date is that there is no clear need to dramatically change any of its parameters.

## **ECONOMIC PERFORMANCE OF THE LEC PRICE CAP PLAN**

The stated purpose of the Commission's review is to conduct a comprehensive examination of the effects of LEC price cap regulation. The Commission invited parties to submit data, analysis and comments regarding ways to improve the current plan. Specifically included among the issues were (i) an examination of the need to change the value of the productivity offset (X) and (ii) whether to make a one-time adjustment to the LEC price cap index or to adopt a mechanism for adjusting the plan to reflect changes in interest rates. In this report, we examine if there is a need to change the value of X and to adjust the price cap index for possible changes in interest rates.

### **I. THE ECONOMIC STRUCTURE OF PRICE CAP REGULATION**

To evaluate the success of an alternative form of regulation, we must have a clear set of criteria that a regulatory plan should meet. Our starting point is the view that (with few exceptions) the competitive process leads to good economic outcomes: just and reasonable prices, suitable levels of service quality, an appropriate return on investment, an efficient use of scarce resources, the proper rate of technical progress, and an adequate incentive to implement and market new products and services. Thus, regulation should foster a competitive outcome in those markets where competition has yet to develop.

To refine the objectives further, a minimal theoretical objective is economic efficiency, i.e., that regulation should emulate competition in producing the most valued mix of goods and services given the limitations imposed by the scarce resources of the economy.<sup>2</sup> Economists distinguish between technical efficiency and allocative efficiency. Technical (or first-order) efficiency means that goods and services are produced at the lowest possible cost. Allocative (or second-order) efficiency means that prices are set so that consumption decisions are based on the true incremental cost of service and consumers thus exchange goods and services at the same rates that it costs society to produce them. The terms "first-order" and "second-order" efficiency refer to the likely magnitude of efficiency losses: technical inefficiency affects all output produced at excessive costs while allocative inefficiency affects only output at the margin, inappropriately stimulated or repressed by prices that differ from marginal cost.

In theory, rate of return (RoR) regulation sets prices equal to realized costs, so that allocative (second-order) efficiency is satisfied. This view of theoretical RoR regulation is a bit too simple for several reasons: (i) RoR regulation sets prices to recover embedded accounting costs, not forward-looking economic costs, and (ii) for a multiproduct firm, RoR sets aggregate prices equal to aggregate (embedded) costs, so that prices need not equal realized costs for each service. In practice, RoR regulation was in place while specific deviations from cost were imposed on numerous services (due, for example, to

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<sup>2</sup>A measure of economic efficiency is the sum of (i) consumer surplus (the difference between what consumers actually pay for their goods and services and what they would be willing to pay) and (ii) producer surplus (the difference between what producers sell their goods and services for and the cost of producing those goods and services). Since the amount consumers actually pay is the same as what producers receive in revenue, this measure is really the difference between what consumers would be willing to pay for goods and services and the cost of producing them.

universal service, carrier of last resort, and readiness to serve obligations). In addition, the firm is given no incentive (in theory) to ensure that realized costs are minimum costs, so that allocative efficiency, if achieved, is achieved at a sacrifice of technical efficiency.<sup>3</sup>

Price cap regulation, in contrast, decouples (i) prices from observed costs and (ii) profits from investment so that the regulated firm has the same incentive to pursue technical (first-order) efficiency as an unregulated firm. The potential risk in decoupling prices from observed costs is that technical efficiency may be achieved at a sacrifice of allocative efficiency: over time, prices may begin to move away from costs.

Mitigating these concerns in the LEC price cap plan is the annual adjustment to the price cap, designed to correct the price cap for cost changes over time in a way that does not reduce incentives to minimize production costs. The annual adjustment to the price cap is carefully constructed to avoid compromising the incentive properties of the plan. In addition, the plan allows for periodic performance reviews which, if carefully conducted, can also be used to balance the achievement of technical and allocative efficiency. If misused, however, the results of a periodic performance review would significantly dilute any improvement in incentives the Commission intended with the adoption of the plan. Adjusting prices or the productivity offset for unanticipated successes or failures under the plan would perversely reward failure and punish success. In addition, a review period of four years is barely sufficient time to observe the effects of

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<sup>3</sup>Of course, actual regulation differs from theoretical regulation, and such features of regulatory practice as regulatory lag and prudence audits diminish somewhat the incentive problems of traditional regulation.

improved incentives on the long-run behavior of the regulated company, and measurement of such changes would be inherently inaccurate.<sup>4</sup>

A pure price cap plan with annual adjustments to the price cap index sets a balance between the objectives of technical and allocative efficiency. Technical efficiency is encouraged because the firm keeps what it earns<sup>5</sup>. The linkages between earnings and investment and between prices and costs are effectively broken. Allocative efficiency is fostered through the annual price cap adjustment and the prudent conduct of periodic reviews.

#### **A. The Logic of the Price Cap Adjustment Formula**

The heart of the LEC price cap plan is the annual adjustment to the price cap.

An annual price cap adjustment consists of three components.

1. a productivity offset (X) which is stable over a long period of time,
2. the annual change in U.S. output prices as measured each year by the GNP fixed weight price index (GNP-PI), and
3. the annual change in costs (Z) due to exogenous events such as regulatory separations or accounting changes.

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<sup>4</sup>For example, one expects improvements in demand and market-related areas (customer relations, marketing, development of new services, etc.) under price cap regulation, since expansion of demand contributes to earnings in the same way as reductions in costs. As a source of productivity change, such improvements are likely to be slower in arriving than the productivity changes from cost reductions which have sustained productivity growth in the telecommunications industry in the past.

<sup>5</sup>This presumes the absence of an earnings sharing mechanism. An earnings sharing mechanism hinders the achievement of technical efficiency.

The logic of the price cap adjustment formula is to select the appropriate productivity offset such that the allowed price changes reflect efficient behavior. The formula for the price cap adjustment can be derived from the relationship among changes in output prices, changes in input prices, and the rate of growth of total factor productivity (TFP) for the firm.

Using that formula and data over some historical period, there are two methods of determining a productivity offset  $X$ :

- (i) a direct method, which calculates the historical rate of TFP growth of the LEC industry from the difference between the growth rates of physical outputs (lines, minutes, etc.) and physical inputs (labor, capital, raw materials) and subtracts the historical rate of TFP growth for the economy as a whole, and
- (ii) an indirect method, which measures the rate of change of output prices for the LEC industry relative to those of the economy as a whole.

The economic principle of duality can be used to show the theoretical equivalence of these two approaches to productivity measurement under certain conditions.

In an accompanying submission in this docket, Christensen Associates perform the direct calculation of LEC industry TFP growth for the 1984-1992 period. The direct approach to the calculation of an offset has two advantages over the indirect approach reported by the Commission at the inception of LEC price cap regulation. First, this measure of a productivity offset uses a measure of capital input based on economic asset lives rather than the implicit regulatory accounting asset lives that are embedded in the prices used in the indirect method of calculating the productivity offset. Economic lives

are presumed to be a more accurate measure of how long capital is useful than the accounting lives which were assigned to accommodate policy goals such as service affordability. Secondly, the direct measure of TFP growth uses lines and minutes as measures of output growth, so that no separate measure of growth in minutes of use per line ("g" in the Balanced 50/50 formula using the indirect method) is necessary to calculate the productivity offset using the direct method.

#### **B. Output Price Changes for the Industry**

A basic identity in economic theory states that--for an individual firm or industry--the rate of growth of TFP is equal to the difference between the rates of growth of the firm's input prices and output prices.<sup>6</sup> Applying this rule to the LEC yields

$$(1) \quad dp = dw - dTFP \pm dZ$$

where  $dp$  represents the annual percentage change in output prices,  $dZ$  represents the unit change in costs due to external circumstances,<sup>7</sup> and  $dw$  represents the annual percentage change in input prices. Thus revenue changes for a price cap regulated firm would tend towards efficiency when the price cap formula (i) increases the firm's output prices at the same rate as its input prices less the offset change in productivity growth, and (ii) directly passes through exogenous cost changes.

Equation (1) looks a great deal like the annual adjustment equation in the LEC price cap plan: the allowed price change for the industry is set at a measure of its input

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<sup>6</sup>This rule is derived in Appendix I by differentiating the identity that total revenue equals total cost.

<sup>7</sup>Note that  $Z^*$  can be positive or negative.

price change less its TFP growth adjusted for exogenous cost pass-throughs. If GNP-PI were taken as a measure of the LECs' input price growth and  $X$  were the its TFP growth, equation (1) would indeed be the same as the LEC price adjustment formula. However, there are three errors in this interpretation. First, if equation (1) applied uniquely to the regulated firm, price cap regulation would not differ materially from traditional RoR regulation. If input prices, productivity growth and exogenous cost changes were updated each year, the output price change that would result in each year would mirror the change in costs, in just the same way as under RoR regulation. Second, GNP-PI measures national output price growth, not the firm or the LEC industry's input price growth, so even if the firm or the industry is a microcosm of U.S. industry, GNP-PI is not an appropriate measure of its input price growth.<sup>8</sup> Third,  $X$  in the LEC plan is a differential TFP growth rate for regulated firms relative to U.S. industry as a whole (or relative to the TFP growth already embodied in the GNP-PI). The change in TFP in equation (1) is the absolute TFP growth for the LEC industry. Again, unless U.S. TFP growth is zero,  $X$  is not equal to  $\dot{dTFP}$ .

To get from equation (1) to the LEC price adjustment formula, we must compare the productivity growth of the LEC industry with the productivity growth of the U.S. economy.

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<sup>8</sup>Recall that input price growth differs from output price growth by the growth in TFP. Hence, only when national productivity growth is zero does GNP-PI growth equals national input price growth.

### C. Output Price Changes for the Economy

For the U.S. economy as a whole, the relationship among input prices, output prices, productivity, and exogenous cost changes can be derived in the same manner as it was derived in equation (1) above, differentiating the identity that the value of output is equal to the expenditure on inputs.

$$(2) \quad dp^N = dw^N - dTFP^N \pm dZ^N$$

where  $dp^N$  is the annual percentage change in a national index of output prices;  $dw^N$  is the annual percentage change in a national index of input prices;  $dTFP^N$  is the annual change in the economy-wide total factor productivity and  $dZ$  represents the change in national output prices caused by the exogenous factors included in equation (1). If we subtract equation (2) from equation (1), we see that

$$dp - dp^N = [dw - dw^N] - [dTFP - dTFP^N] \pm [dZ - dZ^N],$$

or

$$dp = dp^N - [ ( dTFP - dTFP^N ) - ( dw - dw^N ) ] \pm [ dZ - dZ^N ],$$

which simplifies to

$$(3) \quad dp = dp^N - X \pm Z.$$

Equation (3) is the theoretical equivalent of the LEC price adjustment formula. The allowed price change for the regulated firm for a particular year is given by:

1. the rate of inflation of national output prices  $dp^N$  measured by the GNP-PI,
2. less a productivity offset,  $X$ , which now represents a productivity growth differential between the annual TFP growth of the regulated industry and the

U.S. economy, adjusted for differences, if any, between the rate of growth of input prices for the regulated industry and the U.S. as a whole.<sup>9</sup>

3. plus exogenous unit cost changes, written as the difference in the unit costs of the exogenous change between the regulated industry and the U.S. economy.

Simple algebra translates equation (3) into the formula that appears in the LEC price cap plan:

$$(4) \quad P_t = P_{t-1} \times [ 1 + GNP-PI_{t-1} - X ] + Z_{t-1}$$

where  $P_t$  represents the regulated firm's weighted average price using base period quantities. As written, the price cap formula adjusts prices in each period for inflation and exogenous cost changes but leaves the productivity offset held constant during the plan.

Equation (4) is the foundation of the price adjustment formula in the LEC price cap plan. In words, the allowed change in output price for an individual firm is equal to (i) the change in a national index of output prices less (ii) the productivity offset, measured as the difference between the change in LEC TFP and that of the nation as a whole, plus (iii) the difference between the effect of exogenous changes on LEC costs and on the costs of the nation as a whole. National output prices (GNP-PI) and exogenous changes (Z) are measured annually, but the productivity offset (X) is set for a longer period of time.

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<sup>9</sup>This differential is equal to the difference between the firm and U.S. TFP growth rates if the rates of input price growth are the same for the firm and the nation: i.e., if  $dw = dw^N$ . Evidence supporting this assumption was presented by Dr. Laurits Christensen in Appendix F of AT&T's Comments in response to the FCC's Notice of Proposed Rulemaking in CC Docket 87-313, filed October 19, 1987. According to Dr. Christensen's calculations, input cost inflation for the Bell System and for the total U.S. private domestic economy averaged 4.5% and 4.6% respectively for the years 1948 through 1979. A more recent examination of this assumption is undertaken in Section II.B.

The incentive structure of the price cap plan in equation (3) is quite different from that in equation (1). If equation (1) were the basis of a price cap plan, the regulated firm would find its output prices increasing faster than its input prices only if its productivity growth exceeded that of the LEC industry, embodied in the productivity offset  $X$ .<sup>10</sup> If equation (3) were the foundation of the price cap plan, the regulated firm would find its output prices increasing faster than its input prices only if its productivity growth exceeded national productivity growth by more than the historical amount by which LEC industry productivity growth exceeded national productivity growth. In equation (1), the regulated firm effectively competes against a standard set by the LEC industry; if LEC industry TFP growth increased rapidly, the individual firm would have to meet and exceed that productivity growth rate in order for earnings to improve under equation (1). In equation (3), the firm also competes against all other firms in the U.S. economy; if U.S. TFP growth were to increase, the firm would have to match that productivity growth in order to match the historical differential between LEC industry TFP growth and national TFP growth.

If equation (1) were used in a price cap formula, the input price growth rate of the regulated industry would have to be measured, and the industry would be permitted to pass through changes in those input prices through its output prices. Since no outside agency routinely calculates LEC input price indices and since automatic pass-through of input price changes for the industry would diminish its incentives to control those price changes (e.g., through collective bargaining), a price cap plan based on equation (1) would

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<sup>10</sup> Assuming input price growth rates to be the same for the firm and the LEC industry.